

THE U. S. NAVAL OBSERVATORY



Volume 8, Number 1

"All the News that Fits, We Print"

August, 1998

From The Superintendent:

CAPT Dennis G. Larsen

I hope that everyone had a happy holiday season. I, for one, had too much enjoyment, in the food section. It's good to be back to work on a near normal schedule. The command continues to do an outstanding job in support of DOD and the Navy, though we still need to get the word out about these contributions of our USNO professionals. Maybe our Millennium committee will be a good avenue for this. We are now preparing our FY-98 program review which we will provide to RADM Tobin and his staff. The review includes our view of the future and our needs to meet the ever-increasing requirements. Every department is working at peak efficiency and many people are doing much more than their fair share. My thanks go out to you all for your efforts and I will do my best to explain that your value to the Nation is understood and to ensure that you have the proper resources to continue this excellent work.



We had our first-ever open Partnership Council meeting, which I think was a success. Although a relatively small number of command personnel attended, those that did had good ideas, comments, and questions. Thank you all for your participation. The main ideas were published in the POW and the minutes should be on our Intranet Web page in the future. We want, and I think have, an organization that is committed to improve the quality of employment for us all. It appears that communication remains one of our shortfalls and we will continue to try to improve it. Please look at the POW and/or the Intranet to see the specific issues that were addressed. RIFs were brought up and I stated that there are no RIFs planned or anticipated in the near future. This can change quickly, but for now it should not be a concern for anyone. I will ensure that we let you all know as soon as possible, if this changes. We reviewed last year's command assessment results. With over 60 percent of the command participating, there were mostly favorable results. Some areas need improvement and not all command members were totally satisfied. This assessment will be our ground truth for the next assessment to be conducted at the end of March. I hope you all take the time to answer the questions openly and honestly, so that we can see where we need to improve our command climate. Several other issues were raised and the Partnership Council will attempt to answer all of them. I think the most immediate concern on many of our minds is regionalization. I wish I could give you answers on this, but we are just getting started in the negotiation phase with Naval District Washington and CNO-09B (our new claimant for facilities and security). So far, two departments will definitely be affected; they are FM and SO. The implementation and negotiating with the above will last at least through June/July before we have a clear picture of what and how this will affect all of us. I do not think that there will be drastic changes the first year, starting 01 October 1998, but thereafter, I just don't know. It depends on the fiscal climate in the Navy and DOD at that time.

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We have selected several employees for promotions due to increased workloads and responsibilities. Until the paperwork is completed, I cannot officially announce these selections, but I feel that they were all deserved and want to congratulate you all in advance. Those of you who did not get promoted but were nominated are also doing great jobs, so say your supervisors. Thank you for your efforts and maybe next year will be your turn. Finally, those of you who were not nominated are also doing great work. These promotions were for only the GS-12s and above and for only those that are taking on increased responsibilities which justify a higher pay grade. So please continue to do your jobs in such a great manner. After the next couple of months, we will have a better understanding of the regionalization, the budget/program review results and hopefully the view of our futures. So, until then, keep up the good work and enjoy the remainder of our mild (El Niño) winter and the approaching early spring.

CAPT Dennis G. Larsen

From the Scientific Director:

Dr. Kenneth L. Johnston

Observatory Accomplishments in 1997

It is important to see what we have accomplished in the past year as we set new milestones for the future. Without goals we will most probably accomplish little. The Observatory has three very general goals as outlined in our mission statement. They are to meet DoD needs in the areas of precise time and time interval (PTTI), earth orientation parameters, and the precise position of celestial bodies. Many requirements are met by the day to day operation of the Observatory.

The need for precise time, be it at accuracies of days to a nanosecond, is being met by the Master and Alternate Master Clocks. This is one of the Observatory's major accomplishments in 1997. Operations with GPS have been improved through tuning constants of the GPS Kalman filter. Time transfer accuracy of 8 nanoseconds via GPS is now possible. Two Way Satellite Time Transfer (TWSTT)

has expanded to provide precise time to additional high precision users. 1997 saw the initiation of USNO time on SIPRNET giving time to DOD's classified Internet. The STEINTEC measuring system is now operational providing USNO with the capability to measure time at 2ps precision. This improvement will allow an improved understanding of the Master Clock's noise sources, leading to an improvement in time scales. Development of the Cesium fountain has progressed to the point that atoms can now be launched.

Earth orientation parameters were determined biweekly and are now distributed predominately via the Internet; they are available on servers here at the Observatory. This has saved considerable effort in the mailing of this information and has improved the service by making it more current. The effort to determine UT1 via GPS is progressing well and it appears that estimates of UT1 can be used independently of VLBI for about a week. USNO has now developed the ability to provide precise GPS orbits to the International GPS Service (IGS). A pilot project in cooperation with the International Bureau of Weights and Measures (BIPM) was initiated to investigate the use of GPS carrier phase for high precision time transfer.

In the area of astrometry there are many highlights. The IAU officially adopted the International Celestial Reference Frame (ICRF) based largely on work done at USNO. The radio reference frame program has made great progress in obtaining detailed maps for most the sources making up the ICRF north of -30 degrees declination. A program was initiated using the VLBA in 1997 that will obtain one days observation every other month in order to monitor these sources. The observational programs for parallax using the 61-inch telescope continued; observations of double stars using the 26-inch telescope with the speckle camera; asteroids and satellites with the transit telescope, 26- and 61-inch telescopes have also continued. A major achievement was the completion of the *AC2000* catalog. When combined with the *Hipparcos* and *Tycho* catalogs, the *ACT* catalog, which was prepared in time for the IAU General Assembly, is the preferred reference catalog for all users. It has a million stars down to tenth magnitude. The *USNO A.1* and *SA.1* are the best reference catalogs for users requiring reference stars down to twentieth magnitude.

The Optical/IR interferometer nears completion and will soon start its astrometric mission of determining the positions of bright stars. A major accomplishment in 1997 has been the precise measurement of the limb darkening of stars. Work accomplished in 1996 on the imaging of the binary star Mizar A has been awarded an NRL publication award.

The 1998 *Nautical, Air and Astronomical Almanacs* were successfully produced. The MICA 1.5 book and disk are now available providing astronomical software up to 2005. The USNO home page site (www.usno.navy.mil) now contains the International Celestial Reference System (ICRS). The NOVAS routines have been expanded to support the ICRS. The PTTI meeting and Astrometry Form were held very successfully. One outstanding presentation at the Astrometry Form was the explanation of the ICRS and the distribution of the *ACT* catalog.

1997 has been a very successful year for the Observatory. We look forward to a great 1998.

LEGACY FUNDS FOR LIBRARY

Brenda G. Corbin, Librarian

The library is the recipient of additional funds from the Department of Defense Legacy Program. The first funds were received in FY94, and additional funds were received each year through FY96. At that point, we learned that the Legacy Program would end, but much to everyone's surprise, Congress funded a modest amount for FY98.

Two major projects which have been accomplished thus far are the online cataloging of the complete rare book collection by specialized catalogers who are authorities in the intricate rules of rare book description. Rare books are defined as those items published before 1800. Another large project was partial conservation of the rare book collection, but there were not enough funds to complete the conservation.

For the FY98 funding, the Observatory Library made a joint proposal with the Navy Dept. Library for conservation of rare books, and the online cataloging of the 19th century materials. Legacy awarded \$400,000 to this joint project, with \$250,000 going to the Navy Dept. Library (they had

not received any earlier Legacy funds), and \$150,000 to the USNO Library.

The Library hopes to complete the conservation of the rare book collection with part of this funding. The other major project is cataloging all of the 19th century materials online. When this is complete, every item in the Library's collection will be in our online catalog and the bibliographic information will be available to users worldwide.

The Library's current budget has no funds allotted for these important historical projects as all of our budget is spent on journals, current books and online services. This makes the Legacy funds very special indeed, as it allows us to place this valuable material in an online catalog so that astronomers and historians of science will have bibliographic access to these titles.

Security News

Officers Levi Gray Jr, Nadell I. Scott and James W. Waters have completed 40 hours of Phase II, In-Service training (2 - 6 Feb 98). Thanks goes out to Mr. Gary Freeman of National Institute of Health (NIH) for his asking the USNO police to participate in their In-Service Training program.

Officers Leonard A. Golden Jr. and Jerry L. Whitfield are attending 40 hours of Phase II, In-Service training (23 - 27 Feb 98) currently on-going at the Washington Navy Yard. Thanks to the NDW police!

Welcome aboard to Officers Matthew J. Babcock and Robert S. Dyer. Upon completion of their 2 weeks of indoctrination training, both officers will be reassigned to the 2nd shift (1445 - 2315).

USNO POLICE EMERGENCY NUMBERS

34th Street Gate (24 Hours): 762-1468

Shift Lieutenant: 762-0336

Shift Sergeant: 762-0338

Local Emergency Number: Dial 99 + 911.

When calling the local emergency number please notify the USNO police in order to escort the emergency personnel and vehicles to the scene.

GATES (Hours of Operation):

34th Street Gate: Open 24 Hours/7 Days Per Week

South Gate: Open Monday through Friday, 0545 - 1830

Wisconsin Gate: Open Monday - Friday, 0715 - 0900 and 1530 - 1900

Wisconsin Turnstile: 24 Hours Daily (Must have USNO Swipe Card to re-enter)

Davis Street Gate: Closed

Gilliss Avenue Gate: Opened as Directed, otherwise closed

USNO

H*A*P*P*E*N*I*N*G*S

Promotions and Awards



(Above) Superintendent CAPT Dennis Larsen pins the Defense Meritorious Service Medal on XO CDR Mark Gunzelman

*(Below) CAPT Larsen presents IC1(SW) Jerry Carillo with the 1997 USNO "Sailor of the Year" award.
Congratulations, Jerry!*



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Promotions and awards



CAPT Larsen and Kathy Roth add a new stripe to the shoulders of LCDR Mike Roth (FM)



LT Teddy Rosaya (RM) receives his new stripe from CAPT Larsen and XO CDR Gunzelman

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Hail & Farewell



Former Head of the FM Department LCDR Mike Roth and his wife Kathy admire one of their several "going-away" presents. Mike is headed to NWF XXXX in Indiana

New FM Head LT Dan Petno is introduced the USNO staff.



USNO H*A*P*P*E*N*I*N*G*S USNO Christmas Party



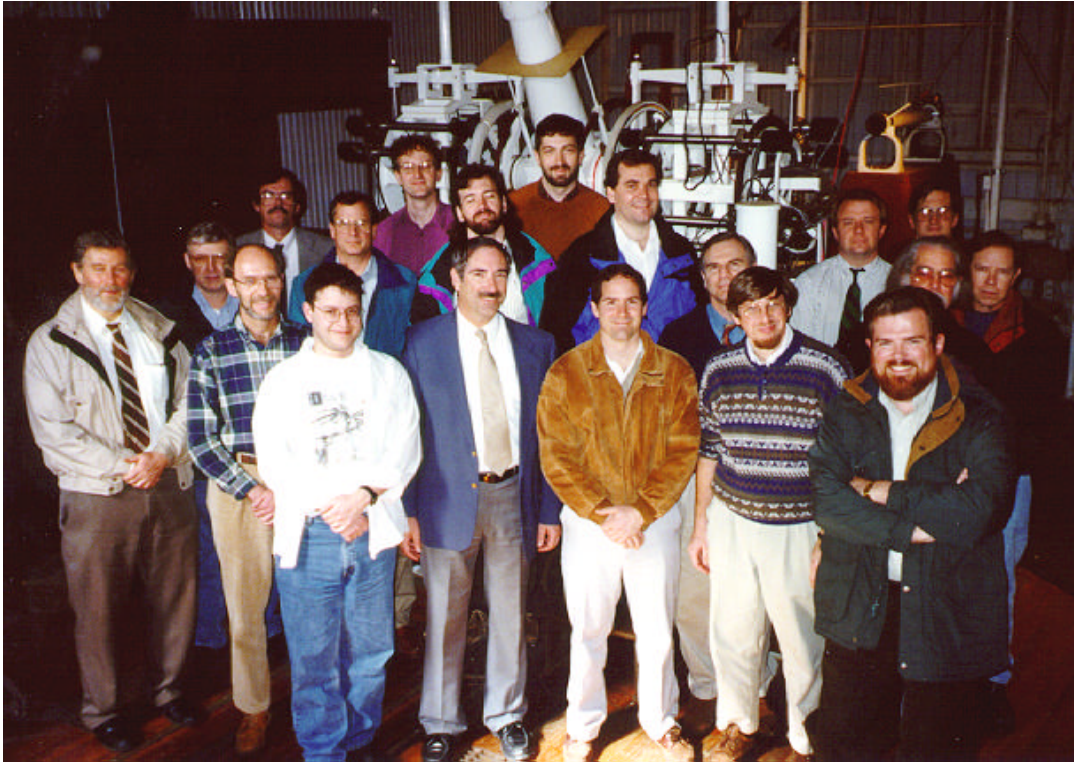
The 1997 USNO Christmas party took place in the Lobby and Library of Building 1. Over 140 past and present USNO Staff enjoyed the fine food of the "Star Gazer Cafe" (above, left), and the traditional visit by Santa Claus (below, right). The faces at left say all that needs to be said!



(Above, right) Former Scientific Directors Kaj Aa. Strand (1963 - 1977) and Gert Westerhout (1977 - 1993) with current SD Ken Johnston.



H*A*P*P*E*N*I*N*G*S



USNO's 6-inch Warner & Swasey Transit Circle Telescope celebrated its Centennial on 14 February. On hand to mark the occasion, members of the Astrometry Department pose with the historic instrument. Although regular use of the telescope ceased in 1995, AD astronomer Ted Rafferty made a few observations on 15 February to extend its use to "over a Century!" Nearly one million program observations were made with the telescope during its long career.



Staff members who couldn't make the journey south to the total solar eclipse of 26 February viewed the 22% partial eclipse through the eyepiece of the 12-inch telescope in Building 1. (Photo by Alan Fey)

ABSTRACTS OF RECENT PAPERS:

U.S. NAVAL OBSERVATORY: CENTER FOR RAPID SERVICE AND PREDICTIONS

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Washington, DC 20392 USA

[to be published in *1998 IGS Analysis Center Workshop Proceedings*, European Space Operations Centre, Darmstadt, Germany]

ABSTRACT:

The mission of the U.S. Naval Observatory (USNO) includes determining the positions and motions of the Earth, Sun, Moon, planets, stars, and other celestial objects, providing precise time, measuring the Earth's rotation, and maintaining the Master Clock for the U.S. The Earth Orientation (EO) Department contributes to this mission by collecting suitable observations and performing data analyses to determine and predict the orientation of the terrestrial reference frame within the celestial reference frame. The key parameters determined and disseminated are polar motion coordinates, Universal Time (UT1), precession, and nutation. The user community includes the U.S. Department of Defense, other U.S. government agencies, scientific researchers, and the general public. The primary applications are for high-accuracy navigation and positioning with an emphasis on real-time uses.

In order to accomplish these objectives, USNO collaborates closely with a large number of other groups and organizations. In particular, the U.S. National Earth Orientation Service (NEOS) is a partnership with the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA) primarily to organize joint VLBI (very long baseline interferometry) operations to monitor Earth orientation. NEOS serves as the VLBI coordinating center for the International Earth Rotation Service (IERS). USNO and NEOS have an enduring commitment to VLBI in order to maintain accurate knowledge of UT1, the celestial pole, and the celestial

reference frame, which is realized by the positions of about 600 extragalactic radio sources. This responsibility is shared with several non-U.S. agencies which contribute essential observing time on their VLBI telescopes.

As with VLBI, the capabilities of GPS also serve important USNO mission objectives. For that reason we have participated actively with the IGS since its inception. Recently, the USNO role in the IGS has grown and further expansion is expected. This report summarizes the current status and future prospects for USNO involvement with GPS and the IGS, together with some recent results.

THE IGS/BIPM TIME TRANSFER PROJECT

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[to be published in *1998 IGS Analysis Center Workshop Proceedings*, European Space Operations Centre, Darmstadt, Germany]

ABSTRACT:

The "IGS/BIPM Pilot Project to Study Accurate Time and Frequency Comparisons using GPS Phase and Code Measurements" was authorized in December 1997 jointly by the International GPS Service for Geodynamics (IGS) and the Bureau International des Poids et Mesures (BIPM). A general Call for Participation was issued shortly afterwards with responses requested by 15 March 1998. The respondents will form a working group co-chaired by C. Thomas, BIPM, and J. Ray, U.S. Naval Observatory (USNO).

A number of groups have been working for several years to develop the capability of using geodetic GPS techniques for accurate time transfer. A variety of convincing demonstrations has already been performed showing the potential for determining clock differences at the level of a few hundred picoseconds. The current state of maturity of both the global tracking network and data analysis techniques now allows practical applications to be considered. The central goal of this Pilot Project is to investigate and develop operational strategies to

exploit GPS measurements for improved availability of accurate time and frequency comparisons worldwide. This will become especially significant for maintaining the international UTC timescale as a new generation of frequency standards emerges with accuracies of 10^{-15} or better.

MICROMETER MEASURES OF DOUBLE STARS

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ABSTRACT

This paper lists 844 means of 795 double stars made with the 26-inch refractor of the U.S. Naval Observatory. The 844 means are derived from 2934 measures, and each set of measures combined into a mean was obtained in the same observing season. The program has concentrated on close pairs exhibiting orbital motion. Other wide pairs are measured as time permits. These data were obtained from 17 September 1984 (1984.713) to 13 May 1990 (1990.366) and represent the last collection of visual micrometry data obtained with the 26-inch prior to the transition to a program of speckle interferometry (see Douglass et al. 1997). The measured separations range from $0''.10$ (21572 \pm 1047 : Aitken 622) to $33''.58$ (14554 \pm 6647 : John Herschel 1259), with a median separation of $0''.98$.

OBSERVATION AND INTERPRETATION OF THE LEONID METEORS OVER THE LAST MILLENNIUM

Steven J. Dick

ABSTRACT:

With a possible "storm" of Leonid meteors due in November 1998 or 1999, interest in the Leonids is once again at a peak. The history of the Leonids is of particular importance, not only because they are closely associated with the origins of meteor science, but also because historical observations extending back a millennium are a substantial aid in increasing our knowledge of the Leonid meteor

stream. Leonid history is thus a prime example of applied historical astronomy. In this review paper we recount the origins of meteor science with the Leonids, the discovery of the historical observations and their scientific and cultural interpretations, and the application of this information to characterize the meteor stream and to predict the strength of the 1998-1999 event. These predictions are now of more than passing interest, as meteor storms pose a potential threat to spacecraft.

A LONG PERIOD SPECTROSCOPIC BINARY IN THE O-STAR MULTIPLE SYSTEM HD 193322

W.P. McKibben, W.G. Bagnuolo, Jr., D.R. Gies, M.E. Hahula, W.I. Hartkopf, H.A. McAlister, L.C. Roberts, Jr., C.T. Bolton, A.W. Fullerton, B.D. Mason, L.R. Penny, and M.L. Thaller

For publication in the August 1998 *Proceedings of the Astronomical Society of the Pacific*

We present radial velocity measurements and a single-lined spectroscopic orbit for the bright O-type star, HD 193322 A, which we show to be a 311 d binary system that has a distant third companion (detected by speckle interferometry) in a 31 y orbit. We suggest that the speckle companion appears in the spectrum as a broad-lined component of an early B-type (and is possibly a rapidly rotating Be star). We also present a spectrum of the visual companion, HD 193322 B, which appears to be an unresolved, double-lined spectroscopic binary. Thus, HD 193322, the central object in the open cluster Collinder 419, is a multiple system of at least 5 stars (possibly 7 if the C and D components are physical). Such systems may play a key role in the dynamical ejection of runaway stars from young clusters.

DESIGN OF THE LONG DELAY LINES FOR THE NAVY PROTOTYPE OPTICAL INTERFEROMETER

James H. Clark III & Long Ha (USRA), and David Mozurkewich & J. Thomas Armstrong (NRL)

To be published in "Astronomical Interferometry", R.D. Reasenberg, ed., *Proc. SPIE*, 3350 (1998)

ABSTRACT:

We have designed a method for introducing the large delays needed for the full 437 meter baseline imaging subarray of the Navy Prototype Optical Interferometer (NPOI). Long delay lines (LDLs) will introduce delay in discrete 29 meter increments for each of the six array elements. In conjunction with the 35 meters of delay from the continuously-variable fast delay lines, the LDLs will allow fringe tracking for all baselines at any position on the sky. We present the mechanical layout, alignment and vacuum design of the LDLs.

A MULTIPLICITY SURVEY OF CHROMOSPHERICALLY ACTIVE AND INACTIVE STARS

by Brian D. Mason, Todd J. Henry, William I. Hartkopf, Theo ten Brummelaar, and David R. Soderblom

Submitted to the *Astronomical Journal*

ABSTRACT:

Surveys of three samples of solar-type stars, segregated by chromospheric emission level, were made to determine their multiplicity fractions and to investigate the evolution of multiplicity with age. In total, 245 stars were searched for companions with $\Delta V < 3.0$ and separations 0.035" to 1.08" using optical speckle interferometry. By incorporating the visual micrometer survey for duplicity of the Lamont-Hussey Observatory the angular coverage was extended to 5.0" with no change in the Δm limit. This magnitude difference allows mass ratios of 0.63 and larger to be detected throughout a search region of 2--127 AU for the stars observed. The 84 primaries observed in the chromospherically active sample are presumably part of a young population, and are found to have a multiplicity fraction of 17.9 ± 4.6 %. The sample of 118 inactive, presumably older, primaries were selected and observed using identical methods, and are found to have a multiplicity fraction of only 8.5 ± 2.7 %. Given the known link between chromospheric activity and age, these results tentatively imply a decreasing stellar multiplicity fraction from one to four Gyr, the approximate ages of the two samples. Finally, only 2 of the 14 very active primaries observed were found to have a

companion meeting the survey detection parameters. In this case, many of the systems are either very young, or close, RS CVn type multiples that are unresolvable using the techniques employed here.

From The Editor

Geoff Chester, Public Affairs Office

Give me enough time and I may just get the hang of this! Another issue of the *Star* is hereby presented for your perusal. I hope it will get into your hands before the next issue of the "Degenerate Star"!

It has been a hectic winter since the last issue of the *Star* came out, but, thanks to El Niño, at least we didn't have to deal with typical Washington winter commutes. I even managed to get a day's skiing in.

The USNO Christmas party was a resounding success. Over 140 people attended, and many "old-timers" came back to mingle with current employees. As a member of the Party Committee (the new guy always gets the tough jobs, right?) I had a chance to work with many of you to ensure a great event. Christine Frego deserves special recognition for all of her insight into past parties, and all of her hard work on this one.

We had a very successful showing at the AAS meeting in January, with Staff presenting several papers and posters. USNO's booth in the exhibit area received lots of traffic, and somewhere around 200 CD-ROMs of *SA1.0*, *AC 2000*, and *ACT Reference Catalogs* were handed out. One passer-by remarked "This is the most useful thing I've gotten at this conference!"

Several of us enjoyed a nice winter break to view the total solar eclipse from the Caribbean. We were welcomed back by a renegade asteroid that kept your Public Affairs Office very busy...for at least one day!

I would like to extend special thanks to all the contributors for this issue. When I sent out the call for articles, the answer was swift and almost overwhelming. Keep 'em coming!

I was pasting up the page of Christmas Party pictures when I realized that almost a quarter of 1998 has flown by. As I stepped off the gangway of the *ms Statendam* after my eclipse cruise, I half-jokingly told Leif Robinson of *Sky & Telescope* that I'd go back home and see if I could reset the Master Clock by ten days so we could do it all over again. What about it, TS?

Actually, a week of uninterrupted time (darn those pesky near-earth asteroids!) would be nice to get this newsletter done in one fell swoop. My goal for this year is to hit the stands on the astronomical season markers (excluding the cross-quarter days...) so keep up the hard work, but please be sure to write up a little something on what you're doing to share with your co-workers.

Volunteers Needed for Monday Night Tours (Still!)

Geoff Chester, Public Affairs Office

As many of you know, the Observatory hosts a tour for the general public every Monday night, except on Federal holidays. This tour is the only chance that most people have to see the workings of a modern, world-class observatory, and it is very popular. This winter we have had several capacity crowds, and the spring and summer promise to be very busy.

It takes a good deal of effort to make these tours proceed smoothly, but most of all it takes a bit of time commitment from those few staff members who like to show off their work place.

I'd like to involve more of you in this worthwhile effort. I don't ask for much, just one evening per month would be fine. If you'd like to help out, just let me know. I'll put you to work right away!

The U.S. Naval Observatory *Star*

U.S. Naval Observatory, Washington, D.C.

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Captain Dennis Larsen

Deputy Superintendent

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Scientific Director

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